TITLE:  SPRINKLERS AND STANDPIPES

TIME REQ'D:  Three (3) hours


INST. LEVEL:  Levels 1 - 2 - 3
Knowledge - Comprehension - Application

MAT. NEEDED:
• Overhead Projector
• Overhead Transparencies
• Sprinkler Prop
• TV / VCR
• Video - “Sprinkler Systems”, Action Training Systems

REFERENCE:
IFSTA "Fire Stream Practices", 7th Edition
NFPA Standard #13, "Sprinkler Systems Installation"
NFPA Standard #14, "Standpipes & Hose Systems"
Fire Service Hydraulics, 2nd Edition
Fire Protection Hydraulics & Water Supply Analysis

OBJECTIVE:  At the end of this class, each apparatus operator shall be able to:
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1. Demonstrate the method specified by the department for augmenting water supplies to sprinkler systems
2. Demonstrate the ability to calculate gallons required for sprinkler systems
3. Demonstrate the minimum hose layouts and pump discharge pressure required to adequately supply a given sprinkler system
4. Demonstrate supplying water to a dry standpipe system using the method specified by the department
5. Demonstrate supplementing water supplies to a standpipe system

MOTIVATION:  Many industrial, commercial, and municipal structures are equipped with on-site fire protection. Part of this fire protection equipment is in
the form of standpipes, both wet and dry, which are used by the firefighters to supply hoselines from inside the structure and automatic sprinkler systems which are activated by the heat. These systems can be a great help to fire suppression activities if supported properly. One of the responsibilities of the apparatus operator is to be certain these systems are supplied with a sufficient quantity of water at the appropriate pressure to provide effective fire streams and/or sprinkler spray patterns. Pre-fire plans and on-site drills will help to ensure these systems are used to their fullest potential.

OVERVIEW: In this presentation we will cover:

1. Support requirements for automatic sprinkler systems
2. Supplying automatic sprinkler systems
3. Support requirements for standpipe systems
4. Classes of standpipe systems
5. Supplying standpipe systems

PRESENTATION: I. SUPPORT REQUIREMENTS FOR AUTOMATIC SPRINKLER SYSTEMS

A. Apparatus

1. Multiple engines may need to be connected to system based on:
   a. Number of sprinkler heads opened
   b. Discharge per head
   c. Pressure loss due to friction and elevation
   d. Intensity of fire

2. Engines should have minimum rated pump capacity of 750 gpm
   a. Discharge will decrease as pressures increase over 150 psi
      (1) 750 gpm at 150 psi
      (2) 525 gpm at 200 psi
      (3) 375 gpm at 250 psi
b. 750 gpm rated engine can supply approximately 37 sprinkler heads flowing 20 gpm each

c. 1000 gpm rated engine can supply approximately 40 sprinkler heads flowing 25 gpm each

d. 1500 gpm rated engine can supply approximately 50 sprinkler heads flowing 30 gpm each

B. Hoseline(s) capable of flowing required quantity of water

1. Always lay minimum of two (2) lines if resources permit

2. Allows:

   a. Lower initial flow pressures through dual lines

   b. Increase in flow should fire escalate

   c. Minimal flow to be maintained if one line were to go down

C. Minimum water pressure delivered to fire department connection should be 150 psi

1. Pressure should be:

   a. Developed slowly

   b. Greater than existing pressure on system

   c. Determined in advance and noted on pre-fire plan

   **NOTE**

   TEST HYDRANT(S) TO VERIFY NEEDED CAPACITY

2. Use as many engines as needed to achieve required pressure
SAFETY NOTE

THE PIPING FOUND IN OLDER SYSTEMS COULD RUPTURE AT THIS PRESSURE. BE SURE TO CHECK THE MAXIMUM RATED PRESSURE OF EACH INDIVIDUAL SYSTEM BEFORE SUPPLYING IT WITH WATER. THIS MAXIMUM PUMPING PRESSURE SHOULD BE NOTED ON THE PRE-FIRE PLAN.

NOTE
CURRENT CODES REQUIRE A SPRINKLER SYSTEM TO WITHSTAND PRESSURES UP TO 175 PSI.

D. Use alternate water supply to prevent taking water already committed to fire protection system

E. Check all control valves to system

F. Do not turn off sprinklers prematurely

G. Keep engine connected to system until overhaul completed

H. Have system restored by qualified personnel before leaving scene

NOTE
IF THE SPRINKLER SYSTEM IS EQUIPPED WITH A FIRE PUMP, DO NOT CONNECT OR INTERFERE WITH THE SYSTEM AS IT IS ENGINEERED TO WORK WITHOUT ASSISTANCE.

II. SUPPLYING AUTOMATIC SPRINKLER SYSTEMS

A. Flow Requirements of Activated System

1. Determined by:

   a. Number of heads open

   b. Type of head

   c. Sprinkler nozzle discharge pressure

      (1) minimum of 8 psi

      (2) flow at 8 psi is 19 gpm approx.
NOTE

ALL SPRINKLER AND STANDPIPE SYSTEM GALLONAGE AND PRESSURE REQUIREMENTS SHOULD BE CALCULATED IN ADVANCE OF AN EMERGENCY AND RECORDED IN THE PRE-FIRE PLAN. THE FIRE SCENE IS NOT THE PLACE FOR PAPER, PENCILS, CALCULATORS, AND HYDRAULICS FORMULAS. IF THE NEEDED CALCULATIONS ARE NOT AT HAND, RULE-OF-THUMB METHODS WILL PROVIDE APPROXIMATE FIGURES THAT CAN BE OBTAINED QUICKLY AND PROVE TO BE SATISFACTORY.

2. "Rule of Thumb" formula to calculate water flow at sprinkler head
   a. \( Q = \frac{1}{2} NP + 15 \)

      (1) \( Q \) is flow in gpm

      (2) \( NP \) is sprinkler head nozzle pressure

3. Find flow of sprinkler with nozzle pressure of 18 psi: (student manual example)
   a. \( Q = \frac{1}{2} NP + 15 \)
   b. \( Q = \frac{1}{2} (18) + 15 \)
   c. \( Q = 9 + 15 \)
   d. \( Q = 24 \text{ gpm} \)

4. Find flow of sprinkler head with nozzle pressure of 24 psi:
   a. \( Q = \frac{1}{2} NP + 15 \)
   b. \( Q = \frac{1}{2} (24) + 15 \)
   c. \( Q = 12 + 15 \)
   d. \( Q = 27 \text{ gpm} \)

5. Find flow of sprinkler head with nozzle pressure of 20 psi:
   a. \( Q = \frac{1}{2} NP + 15 \)
b. \( Q = \frac{1}{2} (20) + 15 \)

c. \( Q = 10 + 15 \)

d. \( Q = 25 \text{ gpm} \)

B. Maximum Flow Requirements of System

1. Determined by:

   a. Total number of heads
   
   b. Type of head
   
   c. Sprinkler nozzle discharge pressure

   (1) minimum of 8 psi

   (2) flow at 8 psi is 19 gpm approx.

2. To find total number of heads in system, use formula:

   a. \( NH = \frac{(L \times W)}{80} \)

   (1) \( NH \) is number of heads

   (2) \( L \) is length of building

   (3) \( W \) is width of building

   (4) 80 is average coverage of one sprinkler head in square feet

3. To find maximum flow for system, use formula:

   a. \( GPM = Q \times NH \)

   (1) \( GPM \) is maximum system flow

   (2) \( Q \) is flow from one sprinkler head

   (3) \( NH \) is total number of heads in system
4. Find flow required to support 40' X 60' sprinkled building with sprinkler head pressure of 20 psi:
   (student manual example)
   
   a. \[ \text{GPM} = Q \times NH \]
      
      (1) \[ Q = \frac{1}{2}NP + 15 \]
      
      (a) \[ Q = \left( \frac{1}{2} \right)(20) + 15 \]
      
      (b) \[ Q = 10 + 15 \]
      
      (c) \[ Q = 25 \]
      
      (2) \[ NH = \frac{L \times W}{80} \]
      
      (a) \[ NH = \frac{40 \times 60}{80} \]
      
      (b) \[ NH = 2400 \div 80 \]
      
      (c) \[ NH = 30 \]
      
   b. \[ \text{GPM} = Q \times NH \]
      
      (1) \[ \text{GPM} = 25 \times 30 \]
      
      (2) \[ \text{GPM} = 750 \]
      
5. Find flow required to support 80' X 40' sprinklered building with sprinkler head pressure of 25 psi:
   (student manual example)
   
   a. \[ \text{GPM} = Q + NH \]
      
      (1) \[ Q = \frac{1}{2}NP + 15 \]
      
      (a) \[ Q = \left( \frac{1}{2} \right)(25) + 15 \]
      
      (b) \[ Q = 12.5 + 15 \]
      
      (c) \[ Q = 27.5 \]
      
      (d) \[ Q = 28 \]

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**NOTE**

**ALWAYS ROUND FRACTIONS / DECIMALS TO NEXT HIGHEST WHOLE NUMBER.**

(d) \[ Q = 28 \]
6. Find flow required to support 60' X 120' sprinklered building with sprinkler head pressure of 20 psi:

a. \[ \text{GPM} = Q \times NH \]

(1) \[ Q = \frac{1}{2}NP + 15 \]

(a) \[ Q = \frac{1}{2}(20) + 15 \]

(b) \[ Q = 10 + 15 \]

(c) \[ Q = 25 \]

(2) \[ NH = \frac{(L \times W)}{80} \]

(a) \[ NH = \frac{60 \times 120}{80} \]

(b) \[ NH = 7200 \div 80 \]

(2) \[ NH = 90 \]

b. \[ \text{GPM} = Q \times NH \]

(1) \[ \text{GPM} = 25 \times 90 \]

(2) \[ \text{GPM} = 2250 \]

7. Find flow required to support 30' X 50' sprinklered building with sprinkler head pressure of 30 psi:

a. \[ \text{GPM} = Q \times NH \]
(1) \[ Q = \frac{1}{2}NP + 15 \]

(a) \[ Q = \left(\frac{1}{2}\right)(30) + 15 \]

(b) \[ Q = 15 + 15 \]

(c) \[ Q = 30 \]

(2) \[ NH = \frac{L \times W}{80} \]

(a) \[ NH = \frac{30 \times 50}{80} \]

(b) \[ NH = 1500 \div 80 \]

(c) \[ NH = 18.75 \text{ or } 19 \]

b. \[ GPM = Q \times NH \]

(1) \[ GPM = 30 \times 19 \]

(2) \[ GPM = 570 \]

8. Find flow required to support 50' x 60' sprinklered building with sprinkler head pressure of 22 psi:

a. \[ GPM = Q \times NH \]

(1) \[ Q = \frac{1}{2}NP + 15 \]

(a) \[ Q = \left(\frac{1}{2}\right)(22) + 15 \]

(b) \[ Q = 11 + 15 \]

(c) \[ Q = 26 \]

(2) \[ NH = \frac{L \times W}{80} \]

(a) \[ NH = \frac{50 \times 60}{80} \]

(b) \[ NH = 3000 \div 80 \]

(c) \[ NH = 37.5 \text{ or } 38 \]

b. \[ GPM = Q \times NH \]
C. Fire Department Support of Sprinkler Systems

1. \( PDP = FL + EL + NP \)
   a. \( PDP \) is pump discharge pressure
   b. \( FL \) is friction loss
      (1) determined by:
         (a) diameter and length of hoselines supplying sprinkler system
         (b) gpm flow
   c. \( EL \) is elevation loss
      (1) it takes .434 psi to push water 1' vertically
      (2) 12' average height per story
      (3) average elevation loss (in psi) per floor is:
         (a) \( .434 \times 12 = 5.208 \) psi
      (4) rule of thumb pressure for elevation loss is:
         (a) 5 psi per floor
   d. \( NP \) is nozzle pressure of sprinkler heads

2. Fire on 8th floor of building has caused 20 sprinkler heads to open. Engine pumping through 400' of dual 2 1/2" lines into fire department connection (FDC). 20 psi required nozzle pressure for sprinklers. Find required PDP. (student manual example)
   a. \( PDP = FL + EL + NP \)
(1) \[ Q = \frac{1}{2}NP + 15 \]

(a) \[ Q = \frac{1}{2}(20) + 15 \]
(b) \[ Q = 10 + 15 \]
(c) \[ Q = 25 \text{ gpm} \]

(2) \[ \text{GPM} = Q \times NH \]

(a) \[ \text{GPM} = 25 \times 20 \]
(b) \[ \text{GPM} = 500 \]

(3) \[ \text{FL} = CQ^2L \]

(a) \[ \text{FL} = 0.5(5)^2(4) \]
(b) \[ \text{FL} = 0.5 \times 25 \times 4 \]
(c) \[ \text{FL} = 0.5 \times 100 \]
(d) \[ \text{FL} = 50 \text{ psi} \]

(4) \[ \text{EL} = \text{number of floors} \times 5 \text{ psi} \]

(a) \[ \text{EL} = 8 \times 5 \]
(b) \[ \text{EL} = 40 \text{ psi} \]

b. \[ \text{PDP} = \text{FL} + \text{EL} + \text{NP} \]

(1) \[ \text{PDP} = 50 + 40 + 20 \]
(2) \[ \text{PDP} = 110 \text{ psi} \]

c. Minimum 500 gpm rated pump required

(1) \[ 500 \text{ gpm @ 150 psi} \]

3. Fire on 3rd floor of building has caused 24 sprinkler heads to open. Engine pumping through 300' of 3" line into fire department connection (FDC). 20 psi required nozzle pressure for sprinklers. Find required PDP. (student manual example)
a. \[ PDP = FL + EL + NP \]

(1) \[ Q = \frac{1}{2}NP + 15 \]

(a) \[ Q = \frac{1}{2}(20) + 15 \]

(b) \[ Q = 10 + 15 \]

(c) \[ Q = 25 \text{ gpm} \]

(2) \[ GPM = Q \times NH \]

(a) \[ GPM = 25 \times 24 \]

(b) \[ GPM = 600 \]

(3) \[ FL = CQ^2L \]

(a) \[ FL = (.8)(6)^2(3) \]

(b) \[ FL = .8 \times 36 \times 3 \]

(c) \[ FL = .8 \times 108 \]

(d) \[ FL = 86.4 \text{ or } 87 \text{ psi} \]

(4) \[ EL = \text{number of floors} \times 5 \text{ psi} \]

(a) \[ EL = 3 \times 5 \]

(b) \[ EL = 15 \text{ psi} \]

b. \[ PDP = FL + EL + NP \]

(1) \[ PDP = 87 + 15 + 20 \]

(2) \[ PDP = 122 \text{ psi} \]

c. Minimum 750 gpm rated pump required

(1) \[ 750 \text{ gpm} @ 150 \text{ psi} \]

4. Fire on 6th floor of building has caused 16 sprinkler heads to open. Engine pumping through 200’ of 2 1/2” line into fire department
connection (FDC). 20 psi required nozzle pressure for sprinklers. Find required PDP.

a. \[ PDP = FL + EL + NP \]

(1) \[ Q = \frac{1}{2}NP + 15 \]

(a) \[ Q = \frac{1}{2}(20) + 15 \]

(b) \[ Q = 10 + 15 \]

(c) \[ Q = 25 \text{ gpm} \]

(2) \[ GPM = Q \times NH \]

(a) \[ GPM = 25 \times 16 \]

(b) \[ GPM = 400 \]

(3) \[ FL = CQ^2L \]

(a) \[ FL = (2)(4)^2(2) \]

(b) \[ FL = 2 \times 16 \times 2 \]

(c) \[ FL = 2 \times 32 \]

(d) \[ FL = 64 \text{ psi} \]

(4) \[ EL = \text{number of floors} \times 5 \text{ psi} \]

(a) \[ EL = 6 \times 5 \]

(b) \[ EL = 6 \times 5 \]

(c) \[ EL = 30 \text{ psi} \]

b. \[ PDP = FL + EL + NP \]

(1) \[ PDP = 64 + 30 + 20 \]

(2) \[ PDP = 114 \text{ psi} \]

c. Minimum 500 gpm rated pump required

(1) \[ 500 \text{ gpm @ 150 psi} \]
5. Fire on 4th floor of building has caused 30 sprinkler heads to open. Engine pumping through 500' of dual 3" lines into FDC. 30 psi required nozzle pressure for sprinklers. Find required PDP.

a. \[ PDP = FL + EL + NP \]

\[
(1) \quad Q = \frac{1}{2}NP + 15
\]

(a) \[ Q = \frac{1}{2}(30) + 15 \]
(b) \[ Q = 15 + 15 \]
(c) \[ Q = 30 \text{ gpm} \]

\[
(2) \quad GPM = Q \times NH
\]

(a) \[ GPM = 30 \times 30 \]
(b) \[ GPM = 900 \]

\[
(3) \quad FL = CQ^2L
\]

(a) \[ FL = \cdot2(9)^2(5) \]
(b) \[ FL = \cdot2 \times 81 \times 5 \]
(c) \[ FL = \cdot2 \times 405 \]
(d) \[ FL = 81 \text{ psi} \]

\[
(4) \quad EL = \text{number of floors} \times 5 \text{ psi}
\]

(a) \[ EL = 4 \times 5 \]
(b) \[ EL = 20 \text{ psi} \]

b. \[ PDP = FL + EL + NP \]

\[
(1) \quad PDP = 81 + 20 + 30
\]

\[
(2) \quad PDP = 131 \text{ psi}
\]

c. Minimum 1000 gpm rated pump required

\[
(1) \quad 1000 \text{ gpm} @ 150 \text{ psi}
\]
6. Fire on 5th floor of building has caused 32 sprinkler heads to open. Engine pumping through 400’ of dual 2 1/2” lines into FDC. 20 psi required nozzle pressure for sprinklers. Find required PDP.

a. \[ \text{PDP} = \text{FL} + \text{EL} + \text{NP} \]

(1) \[ Q = \frac{1}{2}NP + 15 \]

(a) \[ Q = (1/2)(20) + 15 \]

(b) \[ Q = 10 + 15 \]

(c) \[ Q = 25 \text{ gpm} \]

(2) \[ \text{GPM} = Q \times NH \]

(a) \[ \text{GPM} = 25 \times 32 \]

(b) \[ \text{GPM} = 800 \]

(3) \[ \text{FL} = CQ^2L \]

(a) \[ \text{FL} = (.5)(8)^2(4) \]

(b) \[ \text{FL} = .5 \times 64 \times 4 \]

(c) \[ \text{FL} = .5 \times 256 \]

(d) \[ \text{FL} = 128 \text{ psi} \]

(4) \[ \text{EL} = \text{number of floors} \times 5 \text{ psi} \]

(a) \[ \text{EL} = 5 \times 5 \]

(b) \[ \text{EL} = 25 \text{ psi} \]

b. \[ \text{PDP} = \text{FL} + \text{EL} + \text{NP} \]

(1) \[ \text{PDP} = 128 + 25 + 20 \]

(2) \[ \text{PDP} = 173 \text{ psi} \]

c. Minimum 1000 gpm rated pump required
(1) 1000 gpm @ 150 psi

(2) 700 gpm @ 200 psi

(3) 865 gpm @ 175 psi

(a) approximate figure that varies from pump to pump

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III. SUPPORT REQUIREMENTS FOR STANDPIPE SYSTEMS

A. Apparatus

1. Multiple engines may need to be connected to system based on:

   a. Hoseline(s)

   (1) quantity

   (2) size

   (3) gpm discharge

   b. Pressure loss due to friction and elevation

2. Engines should have minimum rated pump capacity of 750 gpm

B. Hoseline(s) capable of flowing required quantity of water

1. Always lay minimum of two (2) lines if resources permit

2. Allows:

   a. Lower initial flow pressures through dual lines

   b. Increase in flow should fire escalate

   c. Minimal flow to be maintained if one line were to go down

C. Minimum water pressure delivered to fire department connection should be 150 psi
1. Pressure should be:
   a. Developed slowly
   b. Greater than existing pressure on system
   c. Determined in advance and noted on pre-fire plan

   **NOTE**
   **TEST HYDRANT(S) TO VERIFY NEEDED CAPACITY**

2. Use as many engines as needed to achieve required pressure

   **SAFETY NOTE**
   **THE PIPING FOUND IN OLDER SYSTEMS COULD RUPTURE AT THIS PRESSURE. BE SURE TO CHECK THE MAXIMUM RATED PRESSURE OF EACH INDIVIDUAL SYSTEM BEFORE SUPPLYING IT WITH WATER. THE MAXIMUM PUMPING PRESSURE SHOULD BE NOTED ON THE PRE-FIRE PLAN.**

   D. Use alternate water supply to prevent taking water already committed to fire protection system

   E. Keep engine connected to system until overhaul completed

IV. **CLASSES OF STANDPIPE SYSTEMS**

A. **Class I**

1. Intended for fire department use only

2. Dry pipe system, independent of sprinkler system, which needs to be charged by fire department at 500 gpm minimum flow

3. Fire department connection (FDC) required

4. Each floor has 2 1/2" male hose connection, with gate, but no hose

5. Roof has two (2) 2 1/2" male hose connections, with gates, but no hose
SAFETY NOTE
A CLASS I STANDPIPE SYSTEM IS GENERALLY LOCATED ON THE OUTSIDE OF A STRUCTURE. DETERIORATION OF THE PIPING AND/OR CONNECTIONS TO THE BUILDING MAKE IT IMPORTANT THAT STANDPIPES BE TESTED EVERY FIVE YEARS TO VERIFY RELIABILITY.

B. Class II
1. Intended for use by building occupants for control of incipient stage fires
2. Wet pipe system connected to domestic water supply
3. Requires minimum flow of 100 gpm @ 65 psi at uppermost outlet
4. Pressure and flow independent from fire department connection (FDC)

NOTE
FIREFIGHTERS SHOULD NOT TRY TO SUPPORT A CLASS II SYSTEM. THEIR RELIABILITY COMES FROM THE DOMESTIC WATER SYSTEM.

C. Class III
1. Capable of furnishing Class I as well as Class II service

NOTE
A CLASS III SYSTEM PROVIDES 1 1/2" & 2 1/2" HOSE CONNECTIONS OR 1 1/2" OR 2 1/2" HOSE STATIONS SUPPLIED FROM A STANDPIPE OR COMBINATION RISER IN ORDER TO SUPPLY WATER FOR USE BY BUILDING OCCUPANTS AND A LARGE VOLUME OF WATER FOR USE BY FIRE DEPARTMENTS AND THOSE TRAINED IN HANDLING HEAVY FIRE STREAMS.
2. Same water flow requirements as Class I
3. Major difference Class I & III:
a. Class I is dry and must be supplied by fire department

b. Class III has its own dedicated water supply that may be augmented by fire department

SAFETY NOTE
WHERE FLOWING PRESSURES AT ANY HOSE VALVE OUTLET EXCEED 100 PSI, AN APPROVED DEVICE SHALL BE INSTALLED AT THE OUTLET TO REDUCE THE PRESSURE WITH REQUIRED FLOW AT THE OUTLET TO 100 PSI. FOR CLASS I & III SYSTEMS, THE APPROVED DEVICE SHALL NOT BE CAPABLE OF BEING ADJUSTED TO PROVIDE PRESSURES HIGHER THAN 100 PSI, IF AVAILABLE, UNLESS SPECIFIED BY THE FIRE DEPARTMENT. THIS KEEPS HOSE LINES ON LOWER FLOORS FROM BEING OVERPRESSURED.
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V. SUPPLYING STANDPIPE SYSTEMS

A. Pump Discharge Pressure (PDP)

1. \[ \text{PDP} = \text{FL} + \text{NP} + \text{EL} + 25 \]

a. PDP is pump discharge pressure

b. FL is friction loss

   (1) determined by:

   (a) diameter and length of hoselines supplying standpipe system
   
   (b) diameter and length of interior attack lines
   
   (c) gpm flow

c. NP is nozzle pressure

d. EL is elevation loss

   (1) it takes .434 psi to push water 1' vertically

   (2) 12' average height per story
(3) average elevation loss (in psi) per floor is:
(a) \[ .434 \times 12 = 5.208 \text{ psi} \]

(4) rule of thumb pressure for elevation loss is:
(a) \[ 5 \text{ psi per floor} \]

e. 25 is average friction loss through standpipe system, ie:

(1) fire department connection (FDC)
(2) standpipe riser
(3) hose outlet valve

2. Find pump discharge pressure required to supply 250 gpm fog nozzle connected to 3rd floor standpipe by 150’ of 2 1/2” hose. You will deliver water to standpipe through parallel lines of 2 1/2” and 3” hose, 400’ in length. (student manual example)

a. \[ \text{PDP} = \text{FL} + \text{NP} + \text{EL} + 25 \]

(1) \[ \text{FL} = CQ^2L \text{ (supply line)} \]
(a) \[ \text{FL} = .3 \times (2.5)^2 \times 4 \]
(b) \[ \text{FL} = .3 \times 6.25 \times 4 \]
(c) \[ \text{FL} = .3 \times 25 \]
(d) \[ \text{FL} = 7.5 \text{ or } 8 \text{ psi} \]

(2) \[ \text{FL} = CQ^2L \text{ (attack line)} \]
(a) \[ \text{FL} = (2)(2.5)^2(1.5) \]
(b) \[ \text{FL} = 2 \times 6.25 \times 1.5 \]
(c) \[ \text{FL} = 2 \times 9.375 \]
(d) $FL = 18.75 \text{ or } 19 \text{ psi}$

(3) $FL = FL \text{ of supply line } + FL \text{ of attack line}$

(a) $FL = 8 + 19$

(b) $FL = 27 \text{ psi}$

(4) $EL = \text{ number of floors } \times 5 \text{ psi}$

(a) $EL = 3 \times 5$

(b) $EL = 15 \text{ psi}$

b. $PDP = FL + NP + EL + 25$

(1) $PDP = 27 + 100 + 15 + 25$

(2) $PDP = 167 \text{ psi}$

3. Find pump discharge pressure required to supply 200 gpm fog nozzle connected to 5th floor standpipe by 150’ of 1 3/4” hose. You will deliver water to standpipe through parallel lines of 3” hose, 800’ in length. (student manual example)

a. $PDP = FL + NP + EL + 25$

(1) $FL = CQ^2L \text{ (supply line)}$

(a) $FL = (.2)(2)^2(8)$

(b) $FL = .2 \times 4 \times 8$

(c) $FL = .2 \times 32$

(d) $FL = 6.4 \text{ or } 7 \text{ psi}$

(2) $FL = CQ^2L \text{ (attack line)}$

(a) $FL = (15.5)(2)^2(1.5)$

(b) $FL = 15.5 \times 4 \times 1.5$

(c) $FL = 15.5 \times 6$
(d) \( \text{FL} = 93 \text{ psi} \)

(3) \( \text{FL} = \text{FL of supply line} + \text{FL of attack line} \)

(a) \( \text{FL} = 7 + 93 \)

(b) \( \text{FL} = 100 \text{ psi} \)

(4) \( \text{EL} = \text{number of floors} \times 5 \text{ psi} \)

(a) \( \text{EL} = 5 \times 5 \)

(b) \( \text{EL} = 25 \text{ psi} \)

b. \( \text{PDP} = \text{FL} + \text{NP} + \text{EL} + 25 \)

(1) \( \text{PDP} = 100 + 100 + 25 + 25 \)

(2) \( \text{PDP} = 250 \text{ psi} \)

4. Find pump discharge pressure required to supply 100 gpm fog nozzle connected to 4th floor standpipe by 200’ of 1 1/2” hose. You will deliver water to standpipe through parallel lines of 3” hose, 500’ in length.

a. \( \text{PDP} = \text{FL} + \text{NP} + \text{EL} + 25 \)

(1) \( \text{FL} = CQ^2L \text{ (supply line)} \)

(a) \( \text{FL} = (.2)(1)^2(5) \)

(b) \( \text{FL} = .2 \times 1 \times 5 \)

(c) \( \text{FL} = .2 \times 5 \)

(d) \( \text{FL} = 1 \text{ psi} \)

(2) \( \text{FL} = CQ^2L \text{ (attack line)} \)

(a) \( \text{FL} = (24)(1)^2(2) \)

(b) \( \text{FL} = 24 \times 1 \times 2 \)

(c) \( \text{FL} = 24 \times 2 \)
(d) \( FL = 48 \text{ psi} \)

(3) \( FL = FL \text{ of supply line} + FL \text{ of attack line} \)

(a) \( FL = 1 + 48 \)

(b) \( FL = 49 \text{ psi} \)

(4) \( EL = \text{number of floors} \times 5 \text{ psi} \)

(a) \( EL = 4 \times 5 \)

(b) \( EL = 20 \text{ psi} \)

b. \( PDP = FL + NP + EL + 25 \)

(1) \( PDP = 49 + 100 + 20 + 25 \)

(2) \( PDP = 194 \text{ psi} \)

5. Find pump discharge pressure required to supply 250 gpm fog nozzle connected to 6th floor standpipe by 200’ of 2 1/2” hose. You will deliver water to standpipe through single 3” hose, 700’ in length.

a. \( PDP = FL + NP + EL + 25 \)

(1) \( FL = CQ^2L \text{ (supply line)} \)

(a) \( FL = (.8)(2.5)^2(7) \)

(b) \( FL = .8 \times 6.25 \times 7 \)

(c) \( FL = .8 \times 43.75 \)

(d) \( FL = 35 \text{ psi} \)

(2) \( FL = CQ^2L \text{ (attack line)} \)

(a) \( FL = (2)(2.5)^2(2) \)

(b) \( FL = 2 \times 6.25 \times 2 \)

(c) \( FL = 2 \times 12.5 \)
(d) FL = 25 psi

(3) FL = FL of supply line + FL of attack line

(a) FL = 35 + 25

(b) FL = 60 psi

(4) EL = number of floors X 5 psi

(a) EL = 6 X 5

(b) EL = 30 psi

b. PDP = FL + NP + EL + 25

(1) PDP = 60 + 100 + 30 + 25

(2) PDP = 215 psi

APPLICATION: In this presentation we have covered:

SUMMARY: 1. Support requirements for automatic sprinkler systems
2. Supplying automatic sprinkler systems
3. Support requirements for standpipe systems
4. Classes of standpipe systems
5. Supplying standpipe systems
to give you a better understanding of how sprinkler and standpipe systems need to be supported to make them effective fire suppression tools. Are there any questions or comments?

CONCLUSION: If there are no further questions, I will now hand out a test which requires a minimum score of 70% to receive credit for the class. We will then go to the drill ground where you shall put to use the information we have just discussed. These tasks must also be satisfactorily completed to receive credit for this class.

ASSIGNMENT:
SPRINKLERS & STANDPIPES EVALUATION

1. T  F  An engine connected to an operating sprinkler system should have a minimum rating of 750 gpm.

2. T  F  The current code requires a sprinkler system to withstand pressures of up to 175 psi.

3. T  F  The minimum water pressure delivered to a fire department connection (FDC) to supply an operating sprinkler system from an engine is 100 psi.

4. T  F  A pressure reducing device must be installed on any hose valve outlet in a standpipe system where the discharge flow pressure could exceed 100 psi.

5. T  F  A Class I standpipe system is designed to be used by building occupants to control incipient stage fires.

\[ Q = \frac{1}{2}NP + 15 \]

6. Find the gallons per minute flow through a sprinkler head with a nozzle pressure of 22 psi.

7. Find the gallons per minute flow through a sprinkler head with a nozzle pressure of 40 psi.

\[ GPM = Q \times NH \]
\[ NH = \frac{L \times W}{80} \]

8. Find the gallons per minute flow required to support a 50’ X 80’ sprinkled building with a sprinkler head pressure of 25 psi.

9. Find the gallons per minute flow required to support a 40’ X 50’ sprinkled building with a sprinkler head pressure of 20 psi.
10. Find the gallons per minute flow required to support a 80' X 100' sprinkled building with a sprinkler head pressure of 24 psi.

\[ PDP = FL + EL + NP \]
\[ FL = CQ^2L \]

11. A fire on the 7th floor of a building has caused 20 sprinkler heads to open. An engine is pumping through 500' of dual 2 1/2" lines into the fire department connection (FDC). The required nozzle pressure for the sprinklers is 24 psi. Find the required pump discharge pressure (PDP).

12. A fire on the 4th floor of a building has caused 25 sprinkler heads to open. An engine is pumping through 400' of 3" line into the fire department connection (FDC). The required nozzle pressure for the sprinklers is 20 psi. Find the required pump discharge pressure (PDP).

13. A fire on the 5th floor of a building has caused 17 sprinkler heads to open. An engine is pumping through 250' of 2 1/2" line into the fire department connection (FDC). The required nozzle pressure for the sprinklers is 25 psi. Find the required pump discharge pressure (PDP).

\[ PDP = FL + NP + EL + 25 \]

14. Find the pump discharge pressure required to supply a 250 gpm fog nozzle connected to a 9th floor standpipe by 200' of 2 1/2" hose. You will deliver water to the standpipe through parallel lines of 3" hose, 750' in length.

15. Find the pump discharge pressure required to supply a 200 gpm fog nozzle connected to a 6th floor standpipe by 150' of 1 3/4" hose. You will deliver water to standpipe through a single 3" hose, 800' in length.
### FRICTION LOSS COEFFICIENTS - SINGLE LINE

<table>
<thead>
<tr>
<th>Hose Diameter (in inches)</th>
<th>Coefficient (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot; booster</td>
<td>1100.0</td>
</tr>
<tr>
<td>1&quot; booster</td>
<td>150.0</td>
</tr>
<tr>
<td>1 1/2&quot;</td>
<td>24.0</td>
</tr>
<tr>
<td>1 3/4&quot;</td>
<td>15.5</td>
</tr>
<tr>
<td>2 1/2&quot;</td>
<td>2.0</td>
</tr>
<tr>
<td>3&quot;</td>
<td>0.8</td>
</tr>
<tr>
<td>4&quot;</td>
<td>0.2</td>
</tr>
<tr>
<td>4 1/2&quot;</td>
<td>0.1</td>
</tr>
<tr>
<td>5&quot;</td>
<td>0.08</td>
</tr>
<tr>
<td>6&quot;</td>
<td>0.05</td>
</tr>
</tbody>
</table>

### FRICTION LOSS COEFFICIENTS - SIAMESED LINES OF EQUAL LENGTH

<table>
<thead>
<tr>
<th>Hose Diameter (in inches)</th>
<th>Coefficient (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two 2 1/2&quot;</td>
<td>0.5</td>
</tr>
<tr>
<td>One 3&quot; &amp; One 2 1/2&quot;</td>
<td>0.3</td>
</tr>
<tr>
<td>Three 2 1/2&quot;</td>
<td>0.22</td>
</tr>
<tr>
<td>Two 3&quot;</td>
<td>0.2</td>
</tr>
<tr>
<td>Two 2 1/2&quot; &amp; One 3&quot;</td>
<td>0.16</td>
</tr>
<tr>
<td>Two 3&quot; &amp; One 2 1/2&quot;</td>
<td>0.12</td>
</tr>
</tbody>
</table>
ANSWER KEY

SPRINKLERS & STANDPIPES EVALUATION

1.  T  F  An engine connected to an operating sprinkler system should have a minimum rating of 750 gpm.

2.  T  F  The current code requires a sprinkler system to withstand pressures of up to 175 psi.

3.  T  F  The minimum water pressure delivered to a fire department connection (FDC) to supply an operating sprinkler system from an engine is 100 psi.

4.  T  F  A pressure reducing device must be installed on any hose valve outlet in a standpipe system where the discharge flow pressure could exceed 100 psi.

5.  T  F  A Class I standpipe system is designed to be used by building occupants to control incipient stage fires.

6.  Find the gallons per minute flow through a sprinkler head with a nozzle pressure of 22 psi.

   \[
   Q = \frac{1}{2}NP + 15
   \]

   \[
   Q = \frac{1}{2}(22) + 15
   \]

   \[
   Q = \frac{1}{2} \times 22 + 15
   \]

   \[
   Q = 11 + 15
   \]

   \[
   Q = 26 \text{ GPM}
   \]

7.  Find the gallons per minute flow through a sprinkler head with a nozzle pressure of 40 psi.

   \[
   Q = \frac{1}{2}NP + 15
   \]

   \[
   Q = \frac{1}{2}(40) + 15
   \]

   \[
   Q = \frac{1}{2} \times 40 + 15
   \]

   \[
   Q = 20 + 15
   \]

   \[
   Q = 35 \text{ GPM}
   \]

8.  Find the gallons per minute flow required to support a 50' X 80' sprinkled building with a sprinkler head pressure of 25 psi.

   \[
   NH = \frac{L \times W}{80}
   \]

   \[
   NH = \frac{50 \times 80}{80}
   \]

   \[
   NH = 50 \times 80 \div 80
   \]

   \[
   NH = 4000 \div 80
   \]

   \[
   NH = 50 \text{ HEADS}
   \]

   \[
   Q = \frac{1}{2}NP + 15
   \]

   \[
   Q = 1/2(25) + 15
   \]

   \[
   Q = \frac{1}{2} \times 25 + 15
   \]

   \[
   Q = 12.5 + 15
   \]

   \[
   Q = 27.5 \text{ GPM}
   \]

   \[
   GPM = Q \times NH
   \]

   \[
   GPM = 27.5 \times 50
   \]

   \[
   GPM = 1375 \text{ GPM}
   \]
9. Find the gallons per minute flow required to support a 40' X 50' sprinkled building with a sprinkler head pressure of 20 psi.

\[
\begin{align*}
\text{NH} &= (L \times W) \div 80 \\
\text{Q} &= \frac{1}{2}NP + 15 \\
\text{GPM} &= Q \times NH \\
\text{NH} &= (40 \times 50) \div 80 \\
\text{Q} &= \frac{1}{2}(20) + 15 \\
\text{GPM} &= 25 \times 25 \\
\text{NH} &= 25 \text{ HEADS} \\
\text{Q} &= 25 \text{ GPM}
\end{align*}
\]

10. Find the gallons per minute flow required to support a 80' X 100' sprinkled building with a sprinkler head pressure of 24 psi.

\[
\begin{align*}
\text{NH} &= (L \times W) \div 80 \\
\text{Q} &= \frac{1}{2}NP + 15 \\
\text{GPM} &= Q \times NH \\
\text{NH} &= (80 \times 100) \div 80 \\
\text{Q} &= \frac{1}{2}(24) + 15 \\
\text{GPM} &= 27 \times 100 \\
\text{NH} &= 100 \text{ HEADS} \\
\text{Q} &= 27 \text{ GPM}
\end{align*}
\]

11. A fire on the 7th floor of a building has caused 20 sprinkler heads to open. An engine is pumping through 500' of dual 2 1/2" lines into the fire department connection (FDC). The required nozzle pressure for the sprinklers is 24 psi. Find the required pump discharge pressure (PDP).

\[
\begin{align*}
\text{Q} &= \frac{1}{2}NP + 15 \\
\text{FL} &= .5CQ^2L \\
\text{EL} &= \# \text{ OF FLOORS} \times 5 \text{ PSI} \\
\text{Q} &= \frac{1}{2}(24) + 15 \\
\text{FL} &= .5(5.4)^2(5) \\
\text{EL} &= 7 \times 5 \\
\text{Q} &= \frac{1}{2} \times 24 + 15 \\
\text{FL} &= .5 \times 29.16 \times 5 \\
\text{EL} &= 35 \text{ PSI} \\
\text{Q} &= 10 + 15 \\
\text{FL} &= .5 \times 145.8 \\
\text{Q} &= 27 \text{ GPM} \\
\text{FL} &= 72.9 \text{ PSI} \\
\text{PDP} &= \text{FL} + \text{EL} + \text{NP} \\
\text{PDP} &= 131.9 \text{ PSI}
\end{align*}
\]

12. A fire on the 4th floor of a building has caused 25 sprinkler heads to open. An engine is pumping through 400' of 3" line into the fire department connection (FDC). The required nozzle pressure for the sprinklers is 20 psi. Find the required pump discharge pressure (PDP).

\[
\begin{align*}
\text{Q} &= \frac{1}{2}NP + 15 \\
\text{FL} &= .5CQ^2L \\
\text{EL} &= \# \text{ OF FLOORS} \times 5 \text{ PSI} \\
\text{Q} &= \frac{1}{2}(20) + 15 \\
\text{FL} &= .8(6.25)^2(4) \\
\text{EL} &= 4 \times 5 \\
\text{Q} &= \frac{1}{2} \times 20 + 15 \\
\text{FL} &= .8 \times 39.0625 \times 4 \\
\text{EL} &= 20 \text{ PSI} \\
\text{Q} &= 10 + 15 \\
\text{FL} &= .8 \times 156.25 \\
\text{Q} &= 25 \text{ GPM} \\
\text{FL} &= 125 \text{ PSI} \\
\text{PDP} &= \text{FL} + \text{EL} + \text{NP} \\
\text{PDP} &= 165 \text{ PSI}
\end{align*}
\]
13. A fire on the 5th floor of a building has caused 17 sprinkler heads to open. An engine is pumping through 250' of 2 1/2" line into the fire department connection (FDC). The required nozzle pressure for the sprinklers is 25 psi. Find the required pump discharge pressure (PDP).

\[
\begin{align*}
Q &= \frac{1}{2}NP + 15 \\
Q &= \frac{1}{2}(25) + 15 \\
Q &= 12.5 + 15 \\
Q &= 27.5 \text{ GPM}
\end{align*}
\]

\[
\begin{align*}
F\ell &= 2 \times 54.6390625 \\
F\ell &= 109.278125 \text{ PSI}
\end{align*}
\]

\[
PDP = F\ell + NP + EL
\]

\[
PDP = 109.278125 + 25 + 25 = 159.278125 \text{ PSI}
\]

14. Find the pump discharge pressure required to supply a 250 gpm fog nozzle connected to a 9th floor standpipe by 200' of 2 1/2" hose. You will deliver water to the standpipe through parallel lines of 3" hose, 750' in length.

\[
\begin{align*}
\text{SUPPLY LINE:} & \quad \text{ATTACK LINE:} \\
F\ell &= CQ^2L \\
F\ell &= (2)(4.675)^2(2.5) \\
F\ell &= 2 \times 21.855625 \times 2.5 \\
F\ell &= 2 \times 54.6390625 \\
F\ell &= 109.278125 \text{ PSI}
\end{align*}
\]

\[
PDP = F\ell + EL + NP
\]

\[
PDP = 109.278125 + 25 + 25 = 159.278125 \text{ PSI}
\]

15. Find the pump discharge pressure required to supply a 200 gpm fog nozzle connected to a 6th floor standpipe by 150' of 1 3/4" hose. You will deliver water to standpipe through a single 3" hose, 800' in length.

\[
\begin{align*}
\text{SUPPLY LINE:} & \quad \text{ATTACK LINE:} \\
F\ell &= CQ^2L \\
F\ell &= (2)(2.5)^2(7.5) \\
F\ell &= 2 \times 6.25 \times 7.5 \\
F\ell &= .8 \times 46.875 \\
F\ell &= 9.375 \text{ PSI}
\end{align*}
\]

\[
PDP = F\ell + NP + EL + 25
\]

\[
PDP = 34.375 + 100 + 45 + 25 = 204.375 \text{ PSI}
\]
STUDENT MANUAL
PUMPER OPERATOR
SPRINKLERS AND STANDPIPES


NFPA Standard #13, "Sprinkler Systems Installation"
NFPA Standard #14, "Standpipes & Hose Systems"
Fire Service Hydraulics, 2nd Edition
Fire Protection Hydraulics & Water Supply Analysis

OBJECTIVES: At the end of this class, each apparatus operator shall be able to:
1. Demonstrate the method specified by the department for augmenting water supplies to sprinkler systems
2. Demonstrate the ability to calculate gallons required for sprinkler systems
3. Demonstrate the minimum hose layouts and pump discharge pressure required to adequately supply a given sprinkler system
4. Demonstrate supplying water to a dry standpipe system using the method specified by the department
5. Demonstrate supplementing water supplies to a standpipe system

I. SUPPORT REQUIREMENTS FOR AUTOMATIC SPRINKLER SYSTEMS

A. Apparatus
1. Multiple engines may need to be connected to system based on:

2. Engines should have minimum rated pump capacity of 750 gpm

B. Hoseline(s) capable of flowing required quantity of water
1. Always lay minimum of two (2) lines if resources permit
C. Minimum water pressure delivered to fire department connection should be 150 psi

1. Pressure should be:

2. Use as many engines as needed to achieve required pressure

**SAFETY NOTE**
The piping found in older systems could rupture at this pressure. Be sure to check the maximum rated pressure of each individual system before supplying it with water. This maximum pumping pressure should be noted on the pre-fire plan.

D. Use alternate water supply to prevent taking water already committed to fire protection system

E. Check all control valves to system

F. Do not turn off sprinklers prematurely

G. Keep engine connected to system until overhaul completed

H. Have system restored by qualified personnel before leaving scene

II. SUPPLYING AUTOMATIC SPRINKLER SYSTEMS

A. Flow Requirements of Activated System

1. Determined by:

**NOTE**
All sprinkler and standpipe system gallonage and pressure requirements should be calculated in advance of an emergency and recorded in the pre-fire plan. The fire scene is not the place for paper, pencils, calculators, and hydraulics formulas. If the needed calculations are not at hand, rule-of-thumb methods will provide approximate figures that can be obtained quickly and prove to be satisfactory.
2. "Rule of Thumb" formula to calculate water flow at sprinkler head
   a. \[ Q = \frac{1}{2} NP + 15 \]
      (1) \( Q \) is flow in gpm
      (2) \( NP \) is sprinkler head nozzle pressure

3. Find flow of sprinkler with nozzle pressure of 18 psi:
   a. \[ Q = \frac{1}{2} NP + 15 \]
   b. \[ Q = \frac{1}{2} (18) + 15 \]
   c. \[ Q = 9 + 15 \]
   d. \[ Q = 24 \text{ gpm} \]

4. Find flow of sprinkler head with nozzle pressure of 24 psi:

5. Find flow of sprinkler head with nozzle pressure of 20 psi:

B. Maximum Flow Requirements of System

1. Determined by:

2. To find total number of heads in system, use formula:
   a. \[ NH = \frac{L \times W}{80} \]
      (1) \( NH \) is number of heads
      (2) \( L \) is length of building
      (3) \( W \) is width of building
3. To find maximum flow for system, use formula:

a. \( GPM = Q \times NH \)

   (1) \( GPM \) is maximum system flow
   (2) \( Q \) is flow from one sprinkler head
   (3) \( NH \) is total number of heads in system

4. Find flow required to support 40’ X 60’ sprinkled building with sprinkler head pressure of 20 psi:

   a. \( GPM = Q \times NH \)

      (1) \( Q = \frac{1}{2}NP + 15 \)

         (a) \( Q = \frac{1}{2}(20) + 15 \)
         (b) \( Q = 10 + 15 \)
         (c) \( Q = 25 \)

      (2) \( NH = \frac{L \times W}{80} \)

         (a) \( NH = \frac{40 \times 60}{80} \)
         (b) \( NH = 2400 \div 80 \)
         (c) \( NH = 30 \)

   b. \( GPM = Q \times NH \)

      (1) \( GPM = 25 \times 30 \)

      (2) \( GPM = 750 \)

5. Find flow required to support 80’ X 40’ sprinklered building with sprinkler head pressure of 25 psi:

   a. \( GPM = Q + NH \)

      (1) \( Q = \frac{1}{2}NP + 15 \)

         (a) \( Q = \frac{1}{2}(25) + 15 \)
(b) \( Q = 12.5 + 15 \)

(c) \( Q = 27.5 \)

**NOTE**

ALWAYS ROUND FRACTIONS / DECIMALS TO NEXT HIGHEST WHOLE NUMBER.

(d) \( Q = 28 \)

(2) \( NH = (L \times W) \div 80 \)

(a) \( NH = (80 \times 40) \div 80 \)

(b) \( NH = 3200 \div 80 \)

(c) \( NH = 40 \)

b. \( GPM = Q \times NH \)

(1) \( GPM = 28 \times 40 \)

(2) \( GPM = 1120 \)

6. Find flow required to support 60’ X 120’ sprinklered building with sprinkler head pressure of 20 psi:

7. Find flow required to support 30’ X 50’ sprinklered building with sprinkler head pressure of 30 psi:

8. Find flow required to support 50’ X 60’ sprinklered building with sprinkler head pressure of 22 psi:
C. Fire Department Support of Sprinkler Systems

1. \( \text{PDP} = \text{FL} + \text{EL} + \text{NP} \)
   a. \( \text{PDP} \) is pump discharge pressure
   b. \( \text{FL} \) is friction loss
      (1) determined by:
   c. \( \text{EL} \) is elevation loss
      (1) it takes .434 psi to push water 1’ vertically
      (2) 12’ average height per story
      (3) average elevation loss (in psi) per floor is:
         (a) \( .434 \times 12 = 5.208 \text{ psi} \)
      (4) rule of thumb pressure for elevation loss is:
         (a) \( 5 \text{ psi per floor} \)
   d. \( \text{NP} \) is nozzle pressure of sprinkler heads

2. Fire on 8th floor of building has caused 20 sprinkler heads to open. Engine pumping through 400’ of dual 2 1/2” lines into fire department connection (FDC). 20 psi required nozzle pressure for sprinklers. Find required PDP.
   a. \( \text{PDP} = \text{FL} + \text{EL} + \text{NP} \)
      (1) \( Q = \frac{1}{2}NP + 15 \)
         (a) \( Q = (1/2)(20) + 15 \)
         (b) \( Q = 10 + 15 \)
         (c) \( Q = 25 \text{ gpm} \)
      (2) \( \text{GPM} = Q \times NH \)
(a) \( \text{GPM} = 25 \times 20 \)

(b) \( \text{GPM} = 500 \)

(3) \( \text{FL} = C Q^2 L \)

(a) \( \text{FL} = (0.5)(5)^2(4) \)

(b) \( \text{FL} = 0.5 \times 25 \times 4 \)

(c) \( \text{FL} = 0.5 \times 100 \)

(d) \( \text{FL} = 50 \text{ psi} \)

(4) \( \text{EL} = \text{number of floors} \times 5 \text{ psi} \)

(a) \( \text{EL} = 8 \times 5 \)

(b) \( \text{EL} = 40 \text{ psi} \)

b. \( \text{PDP} = \text{FL} + \text{EL} + \text{NP} \)

(1) \( \text{PDP} = 50 + 40 + 20 \)

(2) \( \text{PDP} = 110 \text{ psi} \)

3. Fire on 3rd floor of building has caused 24 sprinkler heads to open. Engine pumping through 300’ of 3” line into fire department connection (FDC). 20 psi required nozzle pressure for sprinklers. Find required PDP.

a. \( \text{PDP} = \text{FL} + \text{EL} + \text{NP} \)

(1) \( Q = 1/2 \text{NP} + 15 \)

(a) \( Q = (1/2)(20) + 15 \)

(b) \( Q = 10 + 15 \)

(c) \( Q = 25 \text{ gpm} \)

(2) \( \text{GPM} = Q \times \text{NH} \)

(a) \( \text{GPM} = 25 \times 24 \)

(b) \( \text{GPM} = 600 \)

(3) \( \text{FL} = C Q^2 L \)
(a) $FL = (.8)(6)^2(3)$  
(b) $FL = .8 \times 36 \times 3$  
(c) $FL = .8 \times 108$  
(d) $FL = 86.4$ or $87$ psi  

(4) $EL = \text{number of floors} \times 5$ psi  
(a) $EL = 3 \times 5$  
(b) $EL = 15$ psi  

b. $PDP = FL + EL + NP$  
(1) $PDP = 87 + 15 + 20$  
(2) $PDP = 122$ psi  

4. Fire on 6th floor of building has caused 16 sprinkler heads to open. Engine pumping through 200' of 2 1/2" line into fire department connection (FDC). 20 psi required nozzle pressure for sprinklers. Find required PDP.

5. Fire on 4th floor of building has caused 30 sprinkler heads to open. Engine pumping through 500' of dual 3" lines into FDC. 30 psi required nozzle pressure for sprinklers. Find required PDP.

6. Fire on 5th floor of building has caused 32 sprinkler heads to open. Engine pumping through 400' of dual 2 1/2" lines into FDC. 20 psi required nozzle pressure for sprinklers. Find required PDP.
III. SUPPORT REQUIREMENTS FOR STANDPIPE SYSTEMS

A. Apparatus
   1. Multiple engines may need to be connected to system based on:
   2. Engines should have minimum rated pump capacity of 750 gpm

B. Hoseline(s) capable of flowing required quantity of water
   1. Always lay minimum of two (2) lines if resources permit

C. Minimum water pressure delivered to fire department connection should be 150 psi

SAFETY NOTE
THE PIPING FOUND IN OLDER SYSTEMS COULD RUPTURE AT THIS PRESSURE. BE SURE TO CHECK THE MAXIMUM RATED PRESSURE OF EACH INDIVIDUAL SYSTEM BEFORE SUPPLYING IT WITH WATER. THIS MAXIMUM PUMPING PRESSURE SHOULD BE NOTED ON THE PRE-FIRE PLAN.

D. Use alternate water supply to prevent taking water already committed to fire protection system

E. Keep engine connected to system until overhaul completed

IV. CLASSES OF STANDPIPE SYSTEMS

A. Class I

B. Class II
C. Class III

V. SUPPLYING STANDPIPE SYSTEMS

A. Pump Discharge Pressure (PDP)

1. \[ PDP = FL + NP + EL + 25 \]
   a. \( PDP \) is pump discharge pressure
   b. \( FL \) is friction loss
      (1) determined by:
      (2) 12’ average height per story
      (3) average elevation loss (in psi) per floor is:
         (a) \( .434 \times 12 = 5.208 \) psi
      (4) rule of thumb pressure for elevation loss is:
         (a) \( 5 \text{ psi per floor} \)
   c. \( NP \) is nozzle pressure
   d. \( EL \) is elevation loss
      (1) it takes \( .434 \) psi to push water 1’ vertically
      (2) 12’ average height per story
      (3) average elevation loss (in psi) per floor is:
         (a) \( .434 \times 12 = 5.208 \) psi
   e. \( 25 \) is average friction loss through standpipe system, ie:
      (1) fire department connection (FDC)
      (2) standpipe riser
      (3) hose outlet valve

2. Find pump discharge pressure required to supply 250 gpm fog nozzle connected to 3rd floor standpipe by 150’ of 2 1/2” hose. You will deliver water to standpipe through parallel lines of 2 1/2” and 3” hose, 400’ in length.
a. \[ \text{PDP} = \text{FL} + \text{NP} + \text{EL} + 25 \]

(1) \[ \text{FL} = CQ^2L \text{ (supply line)} \]

(a) \[ \text{FL} = (.3)(2.5)^2(4) \]
(b) \[ \text{FL} = .3 \times 6.25 \times 4 \]
(c) \[ \text{FL} = .3 \times 25 \]
(d) \[ \text{FL} = 7.5 \text{ or } 8 \text{ psi} \]

(2) \[ \text{FL} = CQ^2L \text{ (attack line)} \]

(a) \[ \text{FL} = (2)(2.5)^2(1.5) \]
(b) \[ \text{FL} = 2 \times 6.25 \times 1.5 \]
(c) \[ \text{FL} = 2 \times 9.375 \]
(d) \[ \text{FL} = 18.75 \text{ or } 19 \text{ psi} \]

(3) \[ \text{FL} = \text{FL of supply line} + \text{FL of attack line} \]

(a) \[ \text{FL} = 8 + 19 \]
(b) \[ \text{FL} = 27 \text{ psi} \]

(4) \[ \text{EL} = \text{number of floors} \times 5 \text{ psi} \]

(a) \[ \text{EL} = 3 \times 5 \]
(b) \[ \text{EL} = 15 \text{ psi} \]

b. \[ \text{PDP} = \text{FL} + \text{NP} + \text{EL} + 25 \]

(1) \[ \text{PDP} = 27 + 100 + 15 + 25 \]

(2) \[ \text{PDP} = 167 \text{ psi} \]

3. Find pump discharge pressure required to supply 200 gpm fog nozzle connected to 5th floor standpipe by 150' of 1 3/4'' hose. You will deliver water to standpipe through parallel lines of 3'' hose, 800' in length.

a. \[ \text{PDP} = \text{FL} + \text{NP} + \text{EL} + 25 \]

(1) \[ \text{FL} = CQ^2L \text{ (supply line)} \]
(a) \( FL = (0.2)(2)^2(8) \)

(b) \( FL = 0.2 \times 4 \times 8 \)

(c) \( FL = 0.2 \times 32 \)

(d) \( FL = 6.4 \) or \( 7 \) psi

(2) \( FL = CQ^2L \) (attack line)

(a) \( FL = (15.5)(2)^2(1.5) \)

(b) \( FL = 15.5 \times 4 \times 1.5 \)

(c) \( FL = 15.5 \times 6 \)

(d) \( FL = 93 \) psi

(3) \( FL = \) FL of supply line + FL of attack line

(a) \( FL = 7 + 93 \)

(b) \( FL = 100 \) psi

(4) \( EL = \) number of floors \( \times \) 5 psi

(a) \( EL = 5 \times 5 \)

(b) \( EL = 25 \) psi

b. \( PDP = FL + NP + EL + 25 \)

(1) \( PDP = 100 + 100 + 25 + 25 \)

(2) \( PDP = 250 \) psi

4. Find pump discharge pressure required to supply 100 gpm fog nozzle connected to 4th floor standpipe by 200' of 1 1/2" hose. You will deliver water to standpipe through parallel lines of 3" hose, 500' in length.
5. Find pump discharge pressure required to supply 250 gpm fog nozzle connected to 6th floor standpipe by 200' of 2 1/2" hose. You will deliver water to standpipe through single 3" hose, 700' in length.